ASF Design Considerations for Radarsat/ERS-2

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ABSTRACT

This paper examines the requirements and the design considerations of the Synthetic Aperture Radar (SAR) ground data system for the Alaska SAR Facility (ASF) at the University of Alaska in Fairbanks (UAF) for the new era of Radarsat/ERS-2 missions, These include a new data acquisition planning capability to manage more satellites with global planning and to manage more than one instrument mode; a new archive strategy that is cheaper, faster, and better; a product generation system to produce data on demand and to produce data for the varied instruments and modes; and a product verification ability for the new and old products. In response to these new functional requirements, Jet Propulsion Laboratory (JPL) is using a design approach that emphasizes an open systems, client/server architecture based on industry standards and commercial off-the-shelf technology. This approach will provide room for growth and flexibility in meeting future mission requirements. In addition, the paper will discuss the performance issues and product specifications.

INTRODUCTION

The ASF serves as the ground data system to acquire, process, archive, and distribute SAR data and SAR related products for the science community whose interest include oceanography, glaciology, geology, hydrology, and ecology. ASF is a cooperative program between National Aeronautics and Space Administration (NASA) and UAF in which JPL has the system engineering responsibilities.

Currently, ASF maintains support for two research-oriented satellites which both carry a SAR instrument: the European Space Agency's (ESA) first Earth Remote Sensing satellite (ERS-1) and, the National Space Development Agency (NASDA) of Japan's Earth Resources Satellite (JERS-1). In either late 1994 or early 1995, ESA expects to launch ERS-2, which is the follow-on to ERS-1. In early 1995, Canadian Space Administration (CSA) intends to launch RADARSAT whose only instrument is a SAR to provide data for scientific applications and for operational missions,

These two new satellites introduce notable challenges to ASF in order to meet further demands of science users and operational missions to take advantage of a plethora of capabilities. These capabilities include synergism from multi-satellites, added look angles, and ScanSAR modes.

Additionally, ASF has been identified as one of the Distributed Active Archive Centers (DAAC) that will support interdisciplinary earth science research for the Earth Observation System Data and Information System (EOSDIS). With that selection ASF faces requirements as a DAAC, which include standards and inter-operability within the NASA Earth Science community,

The changes in functional and performance requirements demand an upgraded ground data system, and one of the challenges is to evolve the current system with its capabilities to a new era with more capabilities, greater performance, and higher flexibility.

This paper discusses the effort to evolve ASF from the current operational system to the Radarsat/ERS-2/EOSDIS-DAAC period while meeting the continual demands of the science and operational communities.

ASF ENVIRONMENT

The current ASF system (Berwin, 1992) contains a mixture of hardware and software that was designed to a different set of requirements at a time when the technology was quite different. The current ASF system has the Archive and Catalog Subsystem at the heart of its system. The Alaska SAR processor has a custom built hardware SAR correlator designed especially to process ERS-1 and JERS-1 data. The current subsystems run a mix of UNIX and VMS operating systems.

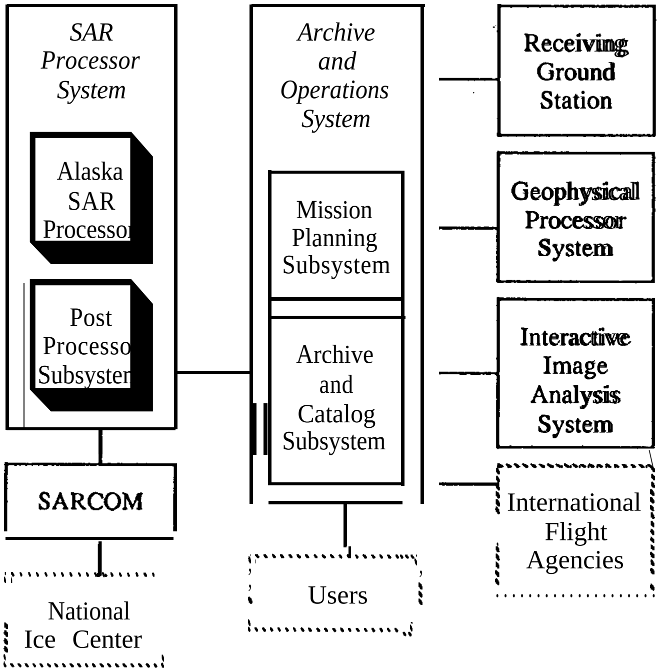

Figure 1.
Block Diagram of Current ASF System

NEW REQUIREMENTS

Requirements for the next generation of ASF comes from new satellites (Radarsat and ERS-2), from EOSDIS to make ASF into one of the DAACS, and a new receiving station. In addition to this, tighter budgets and requirements on NASA to perform better for less money demand that ASF look for new ways to design data systems. It is conceivable that ASF will also have to support other non-SAR missions such as ADEOS. These designs must take into account more flexibility and expandability.

Radarsat

ASF expects to acquire 120 minutes of data per day and process upon demand up to 80 minutes of that to SAR images and related products. Radarsat distinguishes itself from ERS-1, ERS-2, and JERS-1 with the special feature to electronically steer the radar

' beam in many angles, resolutions, and footprints. Hence, Radarsat has many modes which must be accommodated. One of these major modes is called ScanSAR in which the beams are combined in various ways to achieve a wider swath at the sacrifice of spatial resolution. Similar to JERS - 1, Radarsat has an on-board recorder which will allow it to collect data from anywhere on the earth and downlink it later when it passes one of the receiving stations. The radar instrument can measure and transmit data in real-time at the same time it is down-linking previously collected data from its on-board recorder.

ERS-2

As a follow-on mission for the current ERS-1, ERS-2 plans no changes for the SAR instrument performance from the ERS - 1. ASF plans no changes for the SAR processor performance and the data products, except in the daily volume of acquiring and processing data. Although ESA may choose to operate only one satellite at a time, ASF plans to support concurrent operations of both satellites.

EOSDIS/DAAC

Because ASF has been identified as one DAACs, ASF faces requirements which include standards and inter-operability within the NASA Earth Science community. EOSDIS has mandated guidelines to develop systems with an open system architecture, with evolvability due to changes in requirements and availability of new technology, with robustness for operability, and with soundness in design,

McMurdo

NASA is sponsoring a new receiving station at McMurdo Station in the Antarctica, whose facilities and operational support are being provided by the National Science Foundation (NSF). The acquisition planning for this station is to be performed at ASF in cooperation with the Wallops facility. McMurdo will primarily be used to support the Radarsat mission; however it may support many other satellites which wish to study the Antarctic regions.

RESPONSE TO NEW REQUIREMENTS

In response to all these new requirements, JPL is building a new system which will either replace parts of the current system or augment the parts that will remain in place. Figure 2 illustrates the block diagram for the new system. A brief discussion of the DAPPS, IMS/DADS, and SPS will follow.

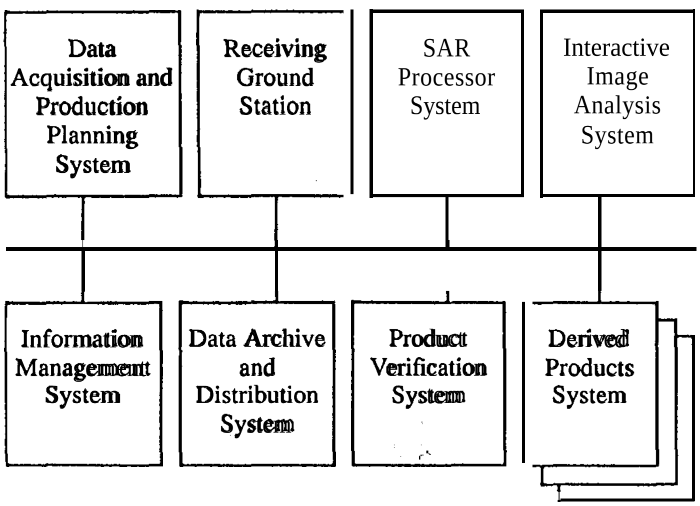

Figure 2.
Block Diagram of ASF for the Radarsat/ERS-2 era.

Data Acquisition rind Production Planning System (DAPPS)

DAPPS is a functional replacement for the mission planning and production planning functions of the current system. DAPPS will perform planning for acquiring data from four satellites and for each of the station masks (ASF and McMurdo). If the ADEOS data is to be acquired at ASF, DAPPS will perform planning for the second antenna at ASF, which would be installed before 1996. The DAPPS function for production planning must manage the tracking of production status for all level products.

Interim IMS/DADS

The ECS contractor will provide a Version 1 IMS/DADS in the 1997/1998 time frame. However, the current system which performs the IMS/DADS functions lacks the necessary functionalities to continue in the Radarsat/ERS-2 era. Therefore an interim IMS/DADS will be built to allow the users uninterrupted access to the data. The IMS will provide the catalog, search, and order functions of the ASF DAAC. DADS will provide the archive and distribution functions. The distribution media will include tape, CD-ROM, film, prints, and on-line electronic transfers. The archives will handle the raw signal data on high density recorders and the various Level 2 products. In order to keep costs within reason, ASF has selected not to archive Level 1 data, and instead to process Level 1 requests on demand from the raw signal data archive.

SAR Processor System (SPS)

SPS will be both upgraded and enhanced. The current ASP will be upgraded to ingest Radarsat data for all its strip modes and process those data to Level 1 products. It is expected that the current ASP capability to process ERS-1 will suffice in processing ERS-2 data. Due to a no Level 1 archive strategy, SPS is planning to scan all raw signal data and provide that data to the catalog so that users can search for availability of signal data for processing. The ScanSAR mode for Radarsat will require a new processor that can process Level 1 products including geocoded and terrain corrected derived products,

In the spirit of placing all ASF subsystems into an open architecture, a software processor to process strip mode data from any of the three satellites will be built that can run on any high performance UNIX workstation.

A product verification subsystem will be built to formalize quality control functions into ASF. This subsystem will Provide image quality assessment, image and calibration/validation in addition to providing support during the commissioning phase.

DESIGN APPROACH FOR ASF

JPL's design approach for the ASF ground data system architecture relies on a set of sound system engineering guidelines that will position ASF to respond to changing requirements in the future. The guidelines that will drive the design of the ASF system architecture are summarized in Table 1 (ESDIS, 1993).

Table 1: Design Guidelines

Guideline	Result
ASF must be developed with an open systems architecture	Highly portable, vendor independent, inter-operable data system
The ASF architecture and design must be evolvable and open to changes in user requirements, programmatic mtssion requirements, and availability of new technology	Logical design, independent of underlying technology elements, modular design, maximum use of standards, maximum use of Commercial Off The Shelf (COTS) software
The ASF architecture and design should be operationally robust	Standard error handling, redundancy where appropriate, end to end system performance analysis
The ASF architecture and design must be sound in principte	Keep It Simple Stupid (KISS) approach, Hierarchical integration testing, rapid development and rapid deployment, cost effective reuse of software

The ASF system architecture is based on a distributed Client/Server model, with functional areas supported by 'servers', which will provide a set of services to client applications, The software architecture is based on a layered model, where subsystem application software is built upon a core of common software-libraries, which in turn are layered on standard operating system, network, and database technologies, as depicted in the software doughnut shown in Figure 3.

Core System Technologies

Unix workstations will form the backbone of the new ASF system hardware architecture. It does not matter which Unix workstation vendor is selected, provided that the environment is POSIX and X/Open compliant.

One major benefit from a standard Unix environment is that high performance networking software, including TCP/IP, Network File System (NFS), Distributed Computing Environment (DCE), and related protocols are generally bundled with the system, or easily obtained,

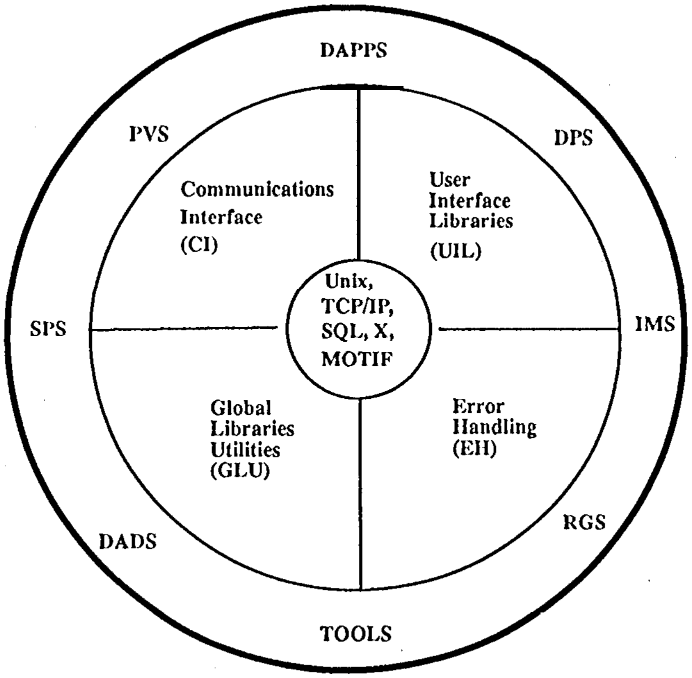

Figure 3.
ASF Software Doughnut

Relational database technology, specifically those implementations that are based on distributed models, also support the underlying TCP/IP protocols. Structured Query Language (SQL) is the *de facto* industry standard for relational products,

The X-window system, from MIT, is the industry standard for network-based windowing software. X runs on a variety of hardware platforms and is supported by virtually all major operating systems. The MOTIF (OSF, 1993) graphical user interface specification from the Open Software Foundation (OSF) provides a de-facto industry standard for windowing software 'look and feel', MOTIF provides the functions for controlling both the behavior of the windows (MOTIF & widget libraries), and their decoration (a MOTIF window manager).

Common Software (a.k.a. Building-Blocks)

The next layer of the doughnut depicts a series of common functions that will be used across all ASF subsystems, This layer of software can be described as 'glue', 'common-ware', 'building-blocks', or simply common software, The idea is that by identifying those functions that are common across subsystems, and then designing and implementing this layer as common software libraries and services, overall software development costs can be reduced and software reliability can be increased. Such an approach also tends to increase system consistency and robustness, since these building-blocks are relatively mature.

Communications Interface (CI)

JPL has selected the Distributed Computing Environment (DCE), an integrated suite of network services developed by the OSF, as the core building block technology for the ASF Communications Interface. DCE is quickly becoming the de-facto industry standard for distributed computing and provides the following services.

User Interface Libraries (UIL)

The OSF/MOTIF Style Guide will be the general design guide used by application developers. Layered on top of the X and MOTIF core technologies are a variety of user interface software libraries and tools, Commercial tools such as U/IMX and Xdesigner will be used to create prototype user interfaces quickly and easily. Additional public domain tools, such as xv, collage, and Mosaic will be used to analyze and manipulate image data.

Error Handling (EH)

JPL will use a standard, system-wide error handling model, together with a standard library of error handling functions. The error handling model being proposed by JPL is based on the syslogo service that comes standard with all Unix systems. The syslog error handling system is based on the concept of separating the error message itself from what actually happens to the message after it is generated. In the syslog model, applications are responsible for generating an error message (with good context and meaning), and then 'delivering' that message to a syslog server, via the syslog() function call. The syslog server receives the message, and based on a configuration file (typically called /etc/syslog.conf) and the priority of the message, determines where it should go. The destination could be a logfile, the console device, or another syslog server on a different computer. This allows system engineers to determine the ultimate behavior for error message generation. In addition, JPL has designed a general purpose logfile browser that, together with access to operator interfaces for appropriate subsystems (IMS, DAPPS), will provide the level of visibility needed, This tool is able to browse any file, filter on selected messages, print any subset of the messages, and trigger alarms based on the content of any message. These alarms will use sound and strategically-placed windows to notify operators of error conditions.

Global Library Utilities (GLU)

GLU is a category of software (libraries and utilities) that will be common across all subsystems in the ASF environment, This common layer will make extensive use of COTS software, and will provide the following types of services: State Management, Queue Management, and Cache Management. State management software will allow ASF subsystems to save the state of their processing and recover this state in the event of serious errors, Queue management will provide a common method for handling queues, Cache management will allow subsystems to store data locally in a controlled and systematic manner.

CONCLUSIONS

ASF upgrade to the Radarsat/ERS-2 era will be achieved through new methods to build an integrated system that is flexible, evolvable, inter-operable, and expandable. It will meet the need to support new satellites and new modes for SAR instruments.

ACKNOWLEDGEMENT

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